Dylon-6

① Nylon-6 is similar to Nylon 6-6. - nature of polymerization

② step-wise condensation, Caprolactam, no net water removal.

** These are some Important Questions which are asked in Interviews:-

→ what is fick's law?

→ what are the units of mass diffusivity?

→ what is diffusivity?

→ What is Boiling point? How B.P will vary high altitudes and lower altitudes.

→ what is gauge pressure.

** → Some times they focus on mainly units

→ Unit operation, Unit proces with examples

→ what is a solvent

→ characters of solvents

→ dry Bulb & wet Bulb

→ What is thermodynamic third law.

→ what is Relative volatility.

→ what is latent heat of vaporization

→ what Bubble point?

→ what is triple point?

→ what is specific heat?

→ If we have 1 ltr of water and 1 hour time the water is at 30°C how much heat will Requires to Increase upto 80°C?

Ans: $q_h = mCp(T_2 - T_1)$

Interview Questions: 29/06/2021

Units: kg, meter, Kelvin, mole.

Force = Newtons

$= kg\,m^1/s$.

$$\text{Density} = \frac{m}{V} = \left[\frac{kg}{m^3}\right]$$

① Area = m^2

② Volume = m^3.

③ Density = kg/m^3

④ Speed = m/s.

⑤ Acceleration = m/s^2

⑥ Pressure = $kg.m^{-1}s^{-2}$

⑦ force = $kg.m.s^{-2}$

$F = kg\,m/s^2$

$F = m \times a$.

$= kg \cdot (m/s^2)$

⑧ Energy = $\frac{kg.m^2}{s^2}$

⑨ Frequency = s^{-1}.

⑩ power = $kg\,m^2/s^3$.

⑪ voltage = $\frac{kg.m^2}{s^3 A}$

⑫ mas density (kg/m^3)

$\frac{(kcal/hr)}{m^2 K} = \left[\frac{W}{m^2 K}\right]$

⑬ concentration → (mol/m^3).

⑭ mas conc → (kg/m^3).

⑮ mass fraction = $\frac{\text{mas of components}}{\text{Total mass of the components}}$

⑯ mole fraction = $\frac{\text{mole of A}}{\text{Total moles}}$.

⑰ Heat Transfer coefficient = $\left(\frac{W}{m^2 K}\right) \equiv U$

$\left(\frac{W}{m^2 K}\right)$

⑱ Mass Transfer coefficient = $\frac{mol}{vol}$.

⑲ what is solvent

⑳ Latent Heat of vapourisation

㉑ Thermodynamic Third Law / and Three laws.

㉒ dry Bulb

㉓ wet Bulb

General Questions:

(1) ** Boiling point : Temperature at which pressure exerted By surroundings upon liquid is equall By pressure exerted By vapour of liquid

Pressure of surroundings = pressure of vapour of liquid.

(2) ** Triple point Temp:

Temp and pressure at which a substance can exist in ~~equation~~ Equilibrium in the liquid, solid and gaseous state

(3) critical point : It is end point of a phase equilibrium curve

ex : liquid-vapour.

(4) ** Roults Law : partial pressure of each component of an Ideal mixture of liquid is equal to the vapour pressure of pure component multiplied By its mole fraction

(Partial pressure) → $P^*_{solution} = x \times P$

P = vapour pressure

x = mole fraction

(5) ** Henry's law :

when a gaseous mixture is in contact with a solution. the amount of any gas in that mixture that dissolve in soln is directly proportional to partial pressure of that gas

→ mole fraction = $\frac{\text{no. of moles of component}}{\text{total no. of moles of component}}$

(7) mole fraction : $\frac{\text{no. of mols of component}}{\text{Total no of mols of component}}$

(8) vapour pressure : Tendency of material to change into gaseous by vapour blar

(9) Gibbs-free -Energy : max amount of mechanical work (or) -Energy done By system under stable Temperature and pressure.

** (10) → As atmospheric pressure (Vapour pressure) decreases ↓ ↑ (water Boils) water Boils at lowes Temp. as sea level water Boils at 212.

-At higher Elevation, the lower atmospheric Pressure means Boiling point reaches Quickly.

(11) guage ~~temp~~ pressure :

The pressure at a point in a fluid above that of the atmosphere.

It is additional pressure is the additional pressure in any system relative to the atmospheric pressure.

→ It is a difference Between absolute and atmospheric proude (9.8.7 psi) positive pressure (48.7 psi)

(12) -Absolute pressure :

Sum of guage pressure and atmospheric pressure

(13) ~~guage temp~~ : Titration : To determine molarity of acid & Base

Malality ; no. of solute present in 1 kg of solvent

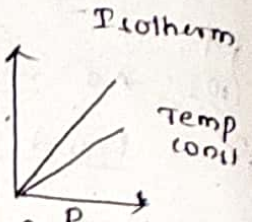
(14) Concentration :

Conc is the abundance of a constituent divided By the total volume of a mixture

(15) Boyles law : $P_1V_1 = P_2V_2$

The volume of a gas at constant Temparature varies inversly with the pressure exerted onit.

(16) Charles law : volume of gas increases as the Temp - Grates Increases



(17) Dalтons law : $P = P_1 + P_2 + \dots$

Total pressure of a mixture gases is equal to the sum of partial pressure of Individual component gas

* Avagadros law := at same P & T an equal volume of gases contains the same no of molecules, regardless of chemical nature 6.023×10^{23}

(18) Molarity := Amount of a substance in a certain volume of solution.

(19) Molality : number of solvent moles per kilogram. mol/kg

(20) Normality : $N = \frac{\text{equivalent wgt}}{\text{volume}}$ [no. of gram equivalent of solute present in one litre solution]

(21) gibbs free energy :

Max amount of mechanical work (or) available energy done by the system under stable Temparature and pressure.

ΔS = Change in Entropy.

(22) Gibbs Temparature :

$$\Delta G = \Delta H - T\Delta S$$

Temp ↑ gibbs free energy ↓

(23) Entropy : measure of disorder

The measure of a system's thermal energy per unit temperature that is unavailable for doing useful work.

(24) Enthalpy : It is a measure of total heat present in the thermodynamic system where the pressure is constant

$$\Delta H = \Delta E + P\Delta V.$$

E = internal energy.

(25) Ideal gas equation = $PV = nRT$

(26) Heat capacity :

amount of heat transfered to raise one mass of the amount of material 1° in temperature amount of energy raised. 1 kg mass By 1° C temperature

VVImp

(27) Specific heat : Ratio of amount of heat transfered to raise unit mass of material 1° in temperature to that required

unit mass of a material / water 1° of temp at some specified temp.

$$C = \frac{c}{m} = \frac{Q}{M\Delta T}$$

Units : $J/kg-^{\circ}C$

Dry Bulb Temp :

(28) Latent Heat of Vapourisation: liquid $\xrightarrow{\text{Temp/BP constant}}$ gas

The temparature remains constant as liquid turns to gas.

Em: Questions

(29) Viscosity: shear stress $\propto$ shear rate. $\left(\tau = \mu \frac{du}{dy}\right)$

(30) Shear stress $\tau = \frac{F}{A}$

(31) Shear Rate = The local velocity rate gradient of fluid.

(32) compressible flow: density changes

(33) potential flow (Irrorational flow)

→ Mechanical energy not converts to Heat energy

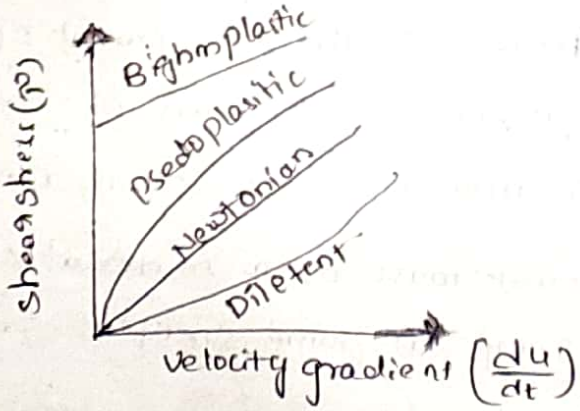
→ no friction Loss

→ Eddies not form

→ friction Development is absent.

→ Shear stress is negligible

→ In compressible and viscosity is zero.



(34) Newtons law of viscosity:

Shear stress $\propto$ shear rate

34.1: shear stress: The unit area amount of force that acts on a given fluid parallel to a small element of surface.

(35) Laminar flow :

flow straight and eddies and cross current do not form without any lateral mixing. adjcent layers slides past one another.

(36) $\tau_t = \epsilon_v \frac{du}{dy}$ ϵ_v = eddies viscosity

kinematic viscosity $= \left(\frac{\mu}{\rho}\right) = \nu$.

(37) Boundary Layer :

fluid flow is influenced by the solid Boundary. It takes to form Boundary Layer.

(38) Re < 2100 Laminar.

Re > 4000 Turblence.

Re > 2100-4000 Terminal flow.

(39) steady flow :

velocity at each Location is constant field don't vary with time.

(40) wall Turblence :

due to the contact of the flowing stream with solid Boundary.

(41) free Turblence :

contact B/w two layers of fluid.

(42) Reynolds Stress :

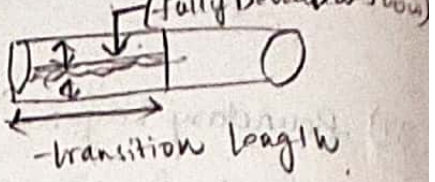
deviating velocities in Turblence.

(43) Shear stress in Turblent flow.

$$\text{Turblent} = \frac{\text{Viscus stress}}{\text{Turblent stress}}$$

(44) Transition Length :

At the centre of the tube fully developed flow is exist that length is called Transition length.



(45) Mass Balance :

Rate of mass flow in − Rate of mass flow out = [Rate of momentum Leaving] + [Sum of forces acing]

(46) Euler Equation = Constant Density and zero viscosity

$$\frac{\rho Dv}{Dt} = -\nabla P + \rho g.$$

(47) Friction factor

Shear stress By velocity Head and density

$$f = \frac{\tau w}{\rho v^2/2}$$

(48) Reynolds number : $Re = \left(\frac{DV\rho}{\mu}\right)$

D = Dia of Pipe
ρ = Density
μ = viscosity

To differentiate the flows weather Turblent, Laminar etc.

(49) Skin friction : $\left[\frac{\Delta Ps}{\rho}\right]$ ⇒ Pressure drop By Density

$$hf = \frac{\Delta Ps}{\rho}.$$

(50) Bernoulis Equation :

$$\frac{P_a}{\rho} + g z_a + \frac{\bar{v}_a^2}{2} = \frac{P_b}{\rho} + g z_b + \frac{\bar{v}_b^2}{2}$$

(μ = viscosity)
Ma = (Speed of fluid / Speed of sound)
Mach number

(51) Bernoulli Assumptions :

→ Unidirectional and Irrotational.
→ steady state
→ Potential flow
→ Incompressible flow.
→ constant velocity
→ without friction.

(52) Average velocity $\bar{V} = \frac{\rho w r_w}{4\mu}$ $\boxed{\frac{\rho w r_w}{4\mu}}$

(53) By Increasing the diameter of the pipe. sheaastrees and friction development is decreaid.

(54) Eddie forms :

(due to sudden Expansion (or) contraction Eddies can form)

(55) Sudden contraction of pipe

$$h_{fc} = k_c \frac{\bar{v}_b^2}{2}.$$

(56) Mach numbers

$$Ma = \frac{\text{speed of fluid}}{\text{speed of sound}} = \frac{u}{a}.$$

Ma < 1 Subsonic
Ma > 1 Supersonic
ma = 1 Sonic

(57) Shaft work is zero for "compressible fluids" gravitational, mechanical, potential energies are Neglected.

(58) acoustical velocity: velocity of sound through a
→ continuous material
→ Adiabatic flow.

(59) stagnition temparature.
High speed fluid temp would attain were it brought to rest adibatically without develpment of shaftwork

$$\therefore \boxed{H_s = H + \left(\frac{u^2}{2}\right)}$$

(60) Iseotropic Expansion:=
→ Stagnition Temp doesnot change in the conduit

(61) Drag: The force in the direction of flow exerted By the fluid on the solid is called drag

opposit-force drag.

(62) Drag Coefficient:

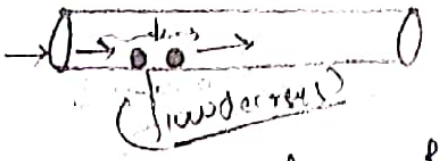
Drag coefficient is the ratio of "shear stress" to the product of velocity Heads and Density.

$$C_d = \frac{F_D}{\Delta p} = C_D = \frac{\left(F_D/A_p\right)}{\rho\left(\frac{V^2}{2}\right)}$$

(63) Creeping flow : (Re<1)

Velocity Reduced wake Area.

If a solid is present in a flow in this case the flow is very low velocity this is called creeping flow.



(64) Form friction :

Drag force is function of form fraction

→ when Boundary Layers seperated form wake Additional Energy dissipation appears with in the wake and friction of this type is called form friction and it is function of position and shape of the solid.

(65) Skin friction :

Friction generated in unseperated Boundary Layers is called "skin friction"

(66) Head of liquid :

pressue is commonly expressed as head. which is the height of the liquid column that would exert that amount of pressure at its Base.

$$2 = \frac{P}{\rho g}$$

(67) Ideal flow :

Re = 1

ρ = Incompressible

(68) Sphericity = $\frac{\text{Surface volume ratio for a sphere}}{\text{Surface volume ratio of particle}} = \frac{D_p}{\delta_p}$

$$\phi_s = \frac{6}{D_p \delta_p / V_p}$$

(69) Porosity (or) void friction:

$$\varepsilon = \frac{\text{volume of void space in the Bed}}{\text{total volume of Bed.}}$$

(70) Bayneed force:

(External force)

$$\varepsilon = \frac{\text{volume of void space in Bed.}}{\text{total volume of Bed.}}$$

The product of mass of the fluid displaced By the particle and the acceleration from the external force.

(71) Terminal velocity:

Particle Reaches a constant velocity which is Maximum attainable under the circumstance and which is called "Terminal Velocity" Denoted By "u_t"

$$\frac{du}{dt} = D$$

$$D = ae\left[\frac{\rho_p - \rho}{\rho_p}\right] - \frac{C_D \rho u^2 A_p}{2m}$$

(72) Fouling factor: During the running of fluid inside the pipe some deposits inside the Tubes These deposits contributes Additional Thermal Resist is fouling factor.

(12) Newton's law of fluid :

The fluid which follows the Newtons law of viscosity.

→ It is applicable only Large particle and Low viscosity of fluid

(13) Fluidization :

when a solid is flowing in a fluid when fluid velocity steadily Increased, pressure drop and drag of individual particle Increases gradually Then the particles starts to move and Become suspended in the fluid is called fluidization.

Types : ① Particle fluidization.

Velocity Increased But average Bed density at given velocity is same in all section of Bed.

② Budding fluidization :

Expansion of Bed comes mainly from the space occupied By gas Bubble.

(14) Transportation :

piping and Tubing : fluid is Transported from one place to another.

Pipe : Heavy walled and Large in diameter of length

Tube : Thin walled and smooth walls

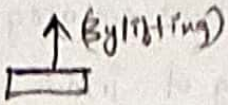
(35) Types of valves :

Tolerence - to control the flow is required

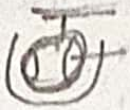
(a) check valves :

→ slow down, pressure decreases

→ liquid flow in one direction

(b) gate valve : 

→ It opens By lifting, pipe axis fully opened and fully closed.

(c) ~~used to~~ Globe valve :  globe.

→ used to regulating the flow.

(d) plug valve : which can be rotated inside the valve to control the flow.

(e) Ball valve : form of Quarter - turn valve uses hallow (or) perforated ~~and~~

(36) pump : which transfer the fluid By Increasing the pressure

KE → pressure energy.

(37) positive displacement pump :

90 - 10 100 % Efficient

It is having more Efficient It is directly converts the pressure energy without

changing. ⟵ By using Reciprocating piston

* **Imp Q:** what is pump priming?

(78) cavitation:

"Suction pressure" is slightly greater than "vapour pressure" some liquid may flash to "vapour inside" the pump.

Suction pressure > vapour pressure

(79) Net positive Suction Head: [NPSH]

To avoid cavitation pressure at the pump inlet must exceed the vapour pressure by certain value is called "Net positive Suction" Head

$$NPSH = \frac{1}{g}\left[\frac{Pa-Pb}{\rho} - h_{fs}\right] - Z_a$$

(80) Net positive minimum Required Suction Head [NPSHR]

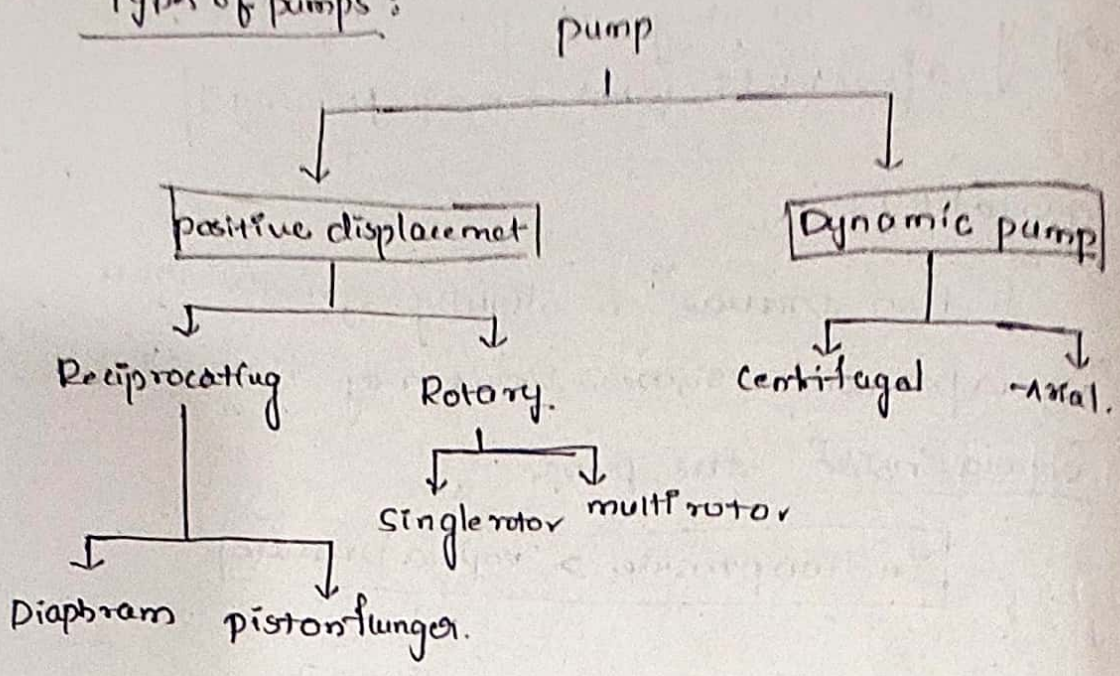
(81) Volumetric Efficiency:

$$= \frac{\text{volume of fluid discharge}}{\text{volume swept By piston}}$$

Causes of cavitation:

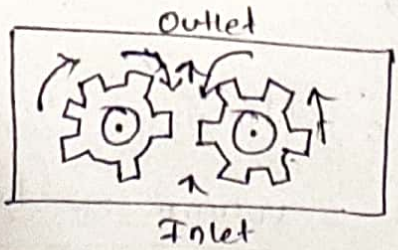
→ High Impeller speed
→ Small dia of suction pipe and inlet of Impeller
→ To high specific speed.

Types of pumps :



Receprocating : The chamber is stationary. cylinder that contains piston.

(82) Rotary pump : By using gears, By rotating inside the opposite direction the fluid is increased its pressure By inlet and delivery at outlet



Types : gear pump

Lobe pump

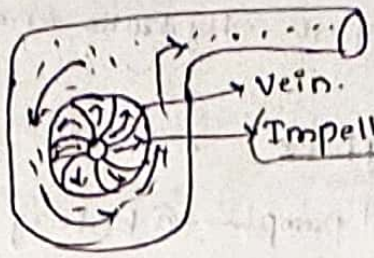
Squae pume

cam pump

vane pump.

(83) Centrifugal pump:

By using impeller rotation K.E of the fluid Increses its pressure.



fluid Increse its K.E By using Impeller rotation is opposite to fluid direction

(84) Multistage Centrifugal pump.: $\eta = 20 - 30\%$

→ In this type of pump which is having more than one Impeller used to Increasing the fluid pressure.

(85) Efficieng of pump:

Efficiency is a ratio of fluid power to the total power consumed.

$$\eta = \frac{P_f}{P_B}$$

(86) power consumption

(power input − power output)

(87) Multi stage Centrifugal pump:

Two (or) more Impellers can be mounted in series on a single shaft

~~Leak proof centrifugal pump~~:

What is pump:- It is Device that moves fluids by some times slurries, By the mechanical actions, Typically converted from Electrical Energy to Hydraulic Energy.

Fluid displacement Types:

① positive displacement pump → ⓐ Rotary Type
② Impulse pump
③ Velocity pump
④ Gravity pump
⑤ valveless pump

ⓑ Reciprocating.
ⓒ Linear Type → Rope / Chain
ⓓ Peristaltic pump.

→ KE is added to fluid. By Increasing flow velocity.
Ex:- Centrifugal pump.

ⓐ Rotary Type:
Gear pump, Screw pump, Rotary vane pump.

ⓑ Reciprocating Type:
→ Diaphram pump
→ Piston pump
→ Radial piston pump
→ vibratory pump.

Impulse pump: pressure created By gas, gas Traped Inside The pump.
Ex:- Hydralic Ram pump.
Pulsex pump, Air lifting pump.

Fans:

Blowers:

CRE:

① what are the CSTR assumptions:
Continuous Stirred tank Reactor.

→ Steady state
→ Constant Temp
→ constant density.
→ Irreversible first order Reactions.

② disadvantages and advantages of PFR:

Advantages:
→ High conversion rate
→ operating cost less

Disadvantages:
→ High maintenance.
→ can't good product control.

***

③ what is unit operation and process with Examples?

Unit operation: only physical change of material can occur.
Ex: Grinding, size Reduction.

Unit process: Only chemical changes occurs.
Ex:- filtration, Distillation.
Hydrolysis, Oxidation, Reduction, Catalysis.

**

④ Thermodynamic Laws:
→ first law: Energy neither be created nor be destroyed. It can only be converted from one form to another.

→ Second Law : When two isolated systems are in separate By regions of space each of them are the thermodynamic Equilibrium in It self.

*** → Third Law :

As Temparatare approches absolute zero, the entropy of a system approches minimam.

→ Entropy of a perfect crystal of each element and a compound is zero at absolute zero.

⑥ carnot Engine : 100 % Efficiency.

⑦ Absolute Temp :

On the Temparature sclare where '0' is absolute zero.

(8) Absolute pressure :

pressure of having no matter inside a space of/ perfect vacuum

(9) Distillation :

It's a method of separation of more volatile component from the less volatile ones of a solution By partial vaporisation of original solution followed By condensation.

(10) Absorption : The proces By which a solid holds moleas of a gas (or) Liquid or solute as a thin film.

(11) Extraction:

Separation of compounds Based on their Relative solubilities into two different Immisible liquids

(12) Crystalization:

which chemical is converted from a liquid soln to solid crystaline state.

(13) Leaching:

Extracting a substance from a solid material that is dissolved in a liquid

Liquid must Be contact with solid matrix containing the substance.

(14) Sublimation: solids are converts into gaseous phase

(15) Evoporation: Liquid substance Becomes gas

(16) Adsorption: Adsorption is an surface theory, molecules will ~~are~~ penetrates on the surfaces

(17) Scrabber: These are used to Remove pollutants from Industrial Exhaust stream

(18) Liquid Hold up:=

The volume of liquid held per volume of packed Bed under operational conditions.

(19) Entrainment:

The Liquid carried by vapour upto tray above.

***

(20) Bubble point:=

The Temparature where the first Bubble of vapour is formed when Heating a liquid consisting of two (or) more components.

(21) Dew points: The point to the temperature the air need to be cooled at in order to achieve a relative humidity (100%)

(22) phase Rule: $F = C - P + 2$

(23) Relative volatility:

Greater the distance from equilibrium line and diagonal, the greater the difference in the Liquid and vapour composition and earlier the separation By Distillation.

$$\alpha = \frac{\frac{y}{(1-y)}}{\frac{x}{(1-x)}} = \frac{y(1-x)}{x(1-y)}.$$

Rv = 0 to 1.

Rv = 1 → (no separation)

Rv > 1 → (grater separation)

Heat Transfer:

Heat always flows from High to Low Temperature difference is driving force of the Heat Transfer Rate.

Mechanism:

(1) conduction:

→ occurs fluid and solids.

→ without Transfer of medium

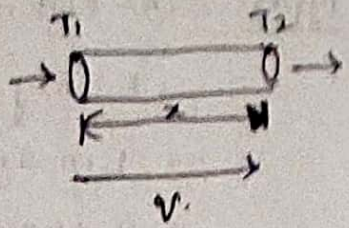
→ fourie's Law.

(2) convection :

→ only in fluids

→ transfer of medium.

→ Newton's Law.



(3) Radiation :

Donot Require medium.

Radiation principle

q = Heat flow / Rate of flow direction of normal.

K = Thermal conductivity.

(4) Fouriers Law of Heat conduction :

Heat flux $\propto$ - (Temparature gradient)

$\frac{dv}{dA} \propto -\frac{dT}{dx}$

$\frac{dv}{dA} \propto -\frac{dT}{dx}$

Heat flux ← → (Temp gradent)

Units :=

→ $v = J/s$ (w) $A = m^2$

$\frac{q}{A}$ Heat flux $= \left(\frac{w}{m^2}\right)$

$K = T$ (or) °C

$x = m$

$\left(\frac{w}{m^2}\right) = (K) \frac{K}{m}$.

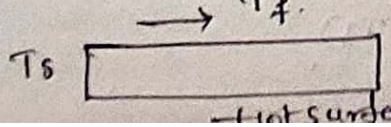
*

$$\frac{dv}{dA} = -k \frac{dT}{dx}$$

(5) convection :

Requires medium / motion of medium.

Newtons Law of cooling : Heat Transfer of solid surface at T_s to moving surface



flux $\propto$ Temp difference

$\frac{q}{A} \propto \Delta T$ $\frac{q}{A} = h(T_s - T_f)$.

Types: ④ Natural convection
→ Buoncy forces
→ Density difference.
→ Temparatea gradent in fluid.

⑤ Forced convection
→ Motion of fluid.
→ Mechanical device

⑥ Radiation: $\varepsilon = \frac{w}{w_b}$. $w = \varepsilon w_b$

$\boxed{w = \varepsilon \sigma T^4}$.

⑦ Heat Transfer By conduction:

Solids: Heat Transfer due to free Electrons.

Liquids: Heat Transfa due to momentum Transfa (or) vibrating molecules / Less conductivity

gases: Heat Transfa due to Random motion of molecules.

$K_{Liquid} < K_{solids}$.

$\boxed{K \downarrow T \uparrow}$ in Liquids.

$\boxed{K \uparrow T \uparrow}$ solids.

$K_{avg} = \frac{K_1 + K_2}{2}$.

(8) Steady state Heat conduction: One dimension
K is constant
steady state
uniform Temp

at S/s: ($q_{in} = q_{out} = q_{const}$)

$q = K A \left[\frac{T_h - T_c}{B}\right]$

⑨ $I = \frac{\Delta T_{comp}}{R_{comp}}$.

$\Delta T_{Comp} = (\Delta T_1) + (\Delta T_2) + (\Delta T_3)$

(Overal Resistance = Sum of Individual Resistance)

(10) Contact Resistance:

Air Resistance B/w two slab layers.

$R_{comp} = R_1 + R_{contact} + R_2$.

$$R_{contact} = \frac{B_{air}}{K_{air} \cdot A}$$

$\Delta T_1 = \Delta T_2 = \Delta T$

(11) Slabs in parallel: $\frac{1}{R_{comp}} = \frac{1}{R_1} + \frac{1}{R_2}$

(12) overall heat Transfer Coefficient: $U = \frac{q_T}{A_T \Delta T_L}$

LMTD $\Delta T_L = \frac{\Delta T_1 - \Delta T_2}{\ln\left[\frac{\Delta T_2}{\Delta T_1}\right]}$

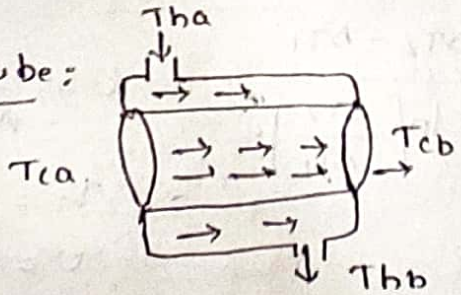
$U = \frac{q_T}{A_T \Delta T_L}$

$U = \frac{q_T}{A_T \Delta L}$

(13) Heat exchangers:

Heat Transfer takes places from the hot fluid to cold fluid.

Shell & Tube:



(14) LMTD: Logarithmic mean Temparature difference.

U = overall heat Transfer coefficient

$\Delta T = T_h - T_c$

Resistance $\propto \frac{1}{\text{Coefficient}}$

(V Imp) ** * $\boxed{Q = mCp\,(\Delta T)}$

→ Cold stream Temp

$$Q_c = \dot{M}_c\, Cp_c\, (T_{cb} - T_{ca})$$

$\dot{m}$ = flow rate

Cp = specific heat

→ Hot stream : $-Q_h = \dot{m}_b\, Cp_b\, (T_{hb} - T_{ha})$

→ Heat gained By cold = Heat given By Hot fluid.

$$Q = m_c\, Cp_c\, (T_{cb} - T_{ca}) = M_h\, Cp_b\, (T_{ha} - T_{hb})$$

Heat Transfer Rate = $\boxed{\frac{dQ}{dA} = U\Delta T}$

$$Q_T = (UA_T)\left[\frac{\Delta T_2 - \Delta T_1}{\ln\left[\frac{\Delta T_2}{\Delta T_1}\right]}\right]$$

. LMTD : $\Delta T_L = \dfrac{\Delta T_2 - \Delta T_1}{\ln\left[\dfrac{\Delta T_2}{\Delta T_1}\right]}$

$$U = \frac{Q_T}{A_T \Delta T_L}$$

Q_T = Heat Transfe

U = overall HT coe

(Q):- fluid is flowing at a Rate of 1000 kmol/hr, at a temp of 30°c How much Temparature Its Require to Increase upto 80°C in 1 hr time

Q_h = m Cp (ΔT)

= 1 x specific Heat of fluid x (80-30)

$\boxed{Q_h = \text{Answer}}$ = 50 (J/kg).

Dimensionless numbers, In heat transfer:

① $Pr = \frac{C_p \mu}{k} = \frac{\text{momentum diffusivity}}{\text{Thermal diffusivity}}$.

② $Nu = \frac{h_x \cdot x}{k}$. $\boxed{Nu = 0.664\ Pr^{1/3} Re^{1/2}}$

③ $Re = \frac{x u_\infty \rho}{\mu}$ (or) $\frac{DV\rho}{\mu}$

④ $\boxed{Pe = Re\ Pr.}$

⑤ $Nu = 2.0\ (G_z^{1/3})$ for low viscus fluid

T.RV

⑥ $\boxed{Gz = \frac{\dot{m} C_p}{kL}}$

⑦ $Pe = \frac{DV}{\alpha}$ α = Thermal diffusivity. $\boxed{\alpha = \frac{k}{\rho C_p}}$

⑧ $\boxed{St = \frac{h}{C_p \rho . V}}$ (or) $\boxed{\frac{Nu}{Re \cdot Pr}}$ $\alpha = \frac{k}{\rho C_p}$ → ρC_p

ϕ_v = correction factor.

Reynolds analogy :=

friction factor $\boxed{f = 0.046\ Re^{-0.2}}$

** Sidestate equation:

$\boxed{Nu = 0.028\ Re^{0.8} Pr^{1/3} \phi_v}$.

$\boxed{St = 0.023\ Re^{-0.2}}$

$St = \frac{f}{2}$.

$\boxed{f = 0.046\ Re^{-0.2}}$

$\boxed{St = \frac{h}{C_p \rho . V}}$ $\frac{w}{C_p \rho . V}$

** Colburn analogy;

$\boxed{Nu = 0.023\ Re^{0.8} Pr^{1/3} \phi_v}$

$St\ Pr^{1/3}\ \phi_v^{-1} = 0.023\ Re^{-0.2}$.

$St\ Pr^{2/3}\ \phi_v^{-1} = f/2$.

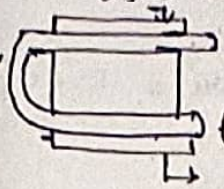
$\boxed{\phi_v = \left[\frac{\mu}{\mu_w}\right]^{0.14}}$ → $\phi_v > 1$ for heating

$\phi_v < 1$ cooling.

for gas $\phi_v = 1$

Types of Heat Exchangers:- Uses Designation conditions Power plants.

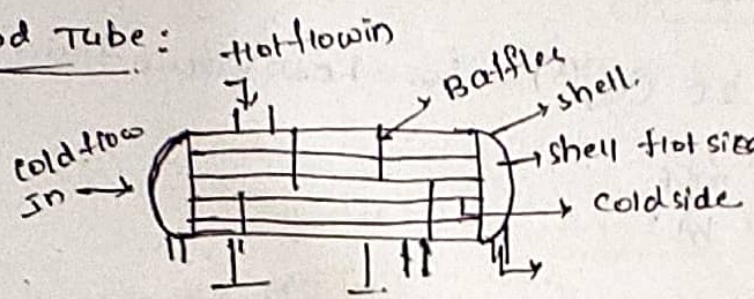
① finned tube HTE: gas HT coefficient is High.
uses in Industries.

② Double pipe →  (Hot)
(fin) → uses in { Digest Heat recovery, preheating

③ shell and tube

④ plate type Heat Exchanger.

Shell and Tube:



Conditions:- High Pre Heating.
Area Temp ↑.
Volume ↑.
Low Efficient.

uses:- cooling of hydrolic fields
cooling of Engine oils.
cooling & Heating of swimming pools.

Baffles: used to supporting the tube
To Increase the turblance direction of flow.

Pump priming: priming is proces of filling the outsource Liquid in the Suction pipe, pump casing, delivery pipe upto delivery value to remove air and water vapour.

for priming open delivery value and relief value and fill the suction pipe casing and delivery value

Interview Questions.

Types of valves: globe valve
gate valve
Ball valve.

Laminar flow:
→ no lateral mixing
→ Eddies, wakes don't form
→ liquid layers pass one another.

Uses of pumps

Toxic liquids, Slurries → Diaphram pumps.

cold water → centrifugal pumps.
Corrosive fluids → peristaltic pumps.
High viscus fluids, Resins feedstocks → gear pumps.

Agitators: uses to shaking and mixing of slurries.
To keep homogeneous liquids.
To dissolves solids into liquids.

Types: Turbine, paddle, anchor, propeller, helical.

→ Paddle: Basic type of agitator.
→ anchor: for high viscus and non-Newtonian fluids
→ Propelles: Low viscus products suspension.
→ Blade type: Low to medium viscus fluids.
→ Turbine: high speed, widly used, high viscosity range
→ Helical: Blade, Threaded, Spiral.
polymer Industry.

PBT = pitch Blade turbine

MTO

① Mass transfer occurs due to conc gradient

② Liquid - Liquid Extraction :

③ Crystalization : evaporating Liquid from a colloidal suspension.

④ Leaching : Extracting Liquid solution By solids, using crushing.

⑤ molecular diffusion : ① movement of Individual molecules Through a substance By virtue of Thermal Energy.

② Transporatation of molecules from High to Low conc,,

③ In Turblent medium is called eddies diffusion

⑥ Eddies diffusion : Transporting of molecules from High to Low concentration in a turblent medium.

⑦ mass Concentration : ρ_i $\rho_i = \frac{P}{RT} \times m_1$

$$\rho = \frac{kg}{m^3}$$

⑧ molar fraction $x_i = \frac{C_i}{C}$

⑨ molar concentration C_i = units : $\frac{Kmol}{m^3}$

⑩ partial pressure $y_i = \frac{P_i}{P}$

⑪ molar average velocity $= \frac{C_i v_i}{C_i} = \frac{1}{C} \sum C_i v_i$

(12) mass flux :

Net Rate of a species of solution passes through a unit area, normal to the direction of diffusion in a unit time.

Units : $\frac{kg.}{m^2.s}$

(13) Ficks's Law :

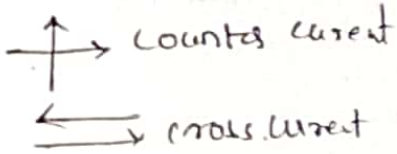
molar flux of an observer moving with any velocity is proportional to concentration gradient

$$J_A \propto \frac{dc_A}{dz}$$

D_{AB} = diffusivity

$$J_A = -D_{AB}\left[\frac{dc_A}{dz}\right]$$

(14) equimolar counter diffusion :



$$N_A + N_B = 0$$

$$N_A = -N_B$$

$$N_A = (N_A + D_B)\frac{P_A}{P}\left[-\frac{D_{AB}}{RT}\right]\left[\frac{dP_A}{dz}\right]$$

$$N_A = \frac{D_{AB}}{RTL}[P_{A0} - P_{AL})$$

(15) Diffusion due to Inter molecular forces / Inter molecule forces in a mixture is governed by collision of diffusion molecules with other present in mix.

J = Surface diffusional flux.

$$J_A = D_s\left[\frac{dc_s}{dz}\right] \qquad D_s = \frac{m^2}{s.} \qquad C_s = \frac{kmol}{m^2}$$

$D_{AB} \propto T$ $\qquad D_{AB} \propto \frac{1}{\text{visosity}}$

(16) Convective mass transfer:
mass transfer occurs under influence of motion of fluids.

free convection: Natural convection is a concentration difference that creat density difference

(free convection)

$\omega_A \propto \Delta C_c$ $\boxed{\omega_A \propto a}$

**

(17) Units of mass transfer coefficient = $\frac{m}{s}$.

(18) k_a, k_g, k_c gas phase MT coefficients

(19) k_c, k_L Liquid phase MT coefficients.

(21) Dimensionless Number MT:

Nu =

Nusselt no = $\frac{\text{convective heat flux / mass flux}}{\text{heat flux of conduction through a stagnient film } *L \times \Delta T}$

$\Rightarrow Nu = \frac{h\Delta T}{\left[\frac{k}{L}\right]\Delta T} = \frac{hL}{k}$. $\boxed{Nu = \frac{hL}{k}}$

$\Rightarrow Sh = \frac{\text{convective m.T}}{L \times \Delta p}$.

$\Rightarrow Pr = \frac{\text{momentum diffusivity}}{\text{Thermal diffusivity}} = \frac{C_p \mu}{k}$.

$\Rightarrow Sc = \frac{\text{momentum diffusivity}}{\text{molar diffusivity}} = \frac{\mu/\rho}{D_{AB}}$.

$\Rightarrow St_m = \frac{St}{(Re)(Sc)}$

⇒ Pe = $\frac{\text{flux due to bulk flow}}{\text{Difference flux across the layer of thickness } \Delta L}$

⇒ Lew's no = $\frac{Sc}{Pr}$. Lewis $\left(\frac{SC}{Pr}\right)$

(22) Theories of MT : film theory.
Penetration theory.
Surface Renual Theory - $K_L = \sqrt{D_{AB} s}$
Boundary Layer

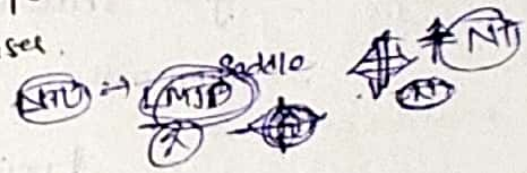
(23) Equilibrium b/w two phases ⇒ No net transfer.

phase rule $\boxed{F = C - P + 2}$

F = no. of constants / degrees of freedom

C = no. of components

P = no. of phases.

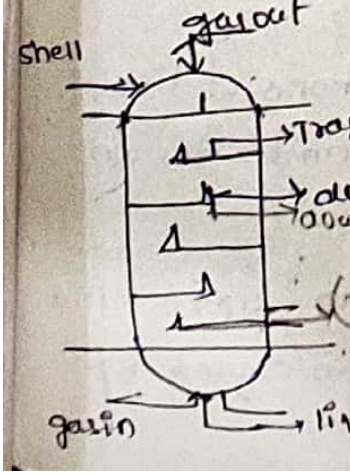


(24) gas-liquid operations :

Liquid contacting equipments are :
→ ① Tray Towers
→ ② Packed towers → (Mall, pall, Soay).
→ ③ Spray Towers

Nire Gauze pac
Super Raching Ri
Intalox ring
pall ring
Rosette ring
Cascade mini Ri
Rasching Ring

(25) Tray Towers : To provide longer contact time b/w gas phase and liquid phase in each tray.



→ (High pumping & operating cost)

***

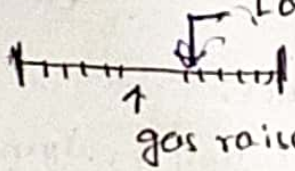
Trouble shootings: In Tray towers.

① flooding: High pressure drop Leads to flooding.

② priming: High gas velocities, Because of foam is present in the Trays Liquid Leads to priming.

③ flooding: The liquid is carried & Recirculated Blw Trays and added liquid Holding Load gives rise to an Increase in pressure drop Leads to flooding.

④ coning: Liquid Rate is low / low flow rates gas raising upwards pushes the liquid upwards



poor, gas liquid contact.

⑤ weeping: gas rate is low, liquid flow rate is high, much liquid rain down through opening of Tray.

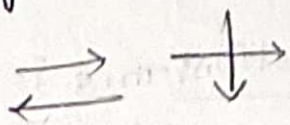
⑥ Dumping: At very Low gas Rates none of liquid reaches the downputs and known as Dumping

⑦ Entrainment: Liquid Carried By vapour, upto the Tray above and is again caused By High vapour flow Rates.

Downcomers: liquid is drawn to the next Lower Tray By means of downcomers

Weirs: These are used to gas-liquid contact time Increase By providing depth on the Tray.

Types of Trays: ① Bubble cap Tray.
② Sieve Tray.
③ Linde Tray.
④ Valve Tray.
⑤ Counter flow Tray.



* Overall efficiency = (no. of Ideal Tray required) / (No. of real Trays required.)

Solvent: The substance which a solute dissloves to produce a homogenous mixture; present greater

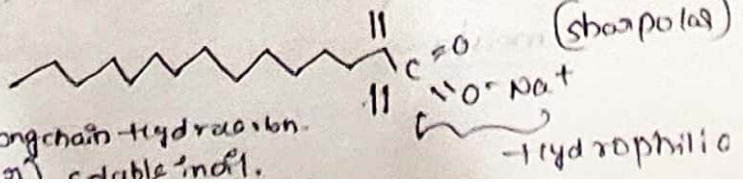
Solute: the substance that dissolve in a solvent to produce homogenous mixture.

Types of solvents: Ethanol, Acetone, methanol, chloroform water, propylene, methyl acetate. Ethyl Acetate, Vinegar.

① Oxygenated
② Halogenated
③ Hydrocarbons.

Hydrophobic: used to remove oil from water. oils, fats, attaches easily to grease

Hydrophilic: which likes to attach water



Buffer: Is an aquel solution which is highly stable pH.
It's Blend of weak acid and it's conjugate Base.

mole: It is unit used to define the no. of Chemical substance present in a substance.

distillation: This is a chemical Technique is used when Boiling point of chemicals are different in mixtures.

Molarity: molarity is used to know the total amount of molecules in a 1-litre solution

Molarity: $\frac{\text{moles of compound}}{\text{Per lit solution}}$

Normality = is used to know the total number of reactive units in a 1 litre of solution

$$\text{Normality} = \frac{\text{gram Equivalent}}{\text{litre.}}$$

Dry Bulb: It is ambient air temparature. indicated By thermometer when it is exposed to air.

wet Bulb: The Lowest Temparature to which air can be cooled By evaporation
another good Indication of atmospheric moisture.

Bubble point : It is the point at which the first drop of a liquid mixture begins to vapourise.

Dew point : The temperature at which water vapour start to condense out of the air [The temperature at which the air becomes completely saturated)

Packed towers :=

→ Tray tower

① can handle solids
② High liquid rates

Packed tower

→ ① Lowe ($\frac{\Delta P}{}$) (pressure drop)
→ ② Smaller the column dia
③

$$\eta = (\text{thi} - \text{TCO}) - (\text{Thi} - \text{TBP})$$

Azeotropic mixture in Aspen plus :—

→ Azeotropic mixture is a solution of two or more liquids, the composition of which doesn't change upon distillation.
The composition of liquid phase of Boiling point is identical to that of the vapours in equilibrium with it, and such mixture is known as Azeotrope or Azeotrope term.

Constant Boiling solution

The exact composition changes if the Boiling point is altered by change in external pressure.

→ One of the most common methods to break an azeotrope includes adding a material separation agent that has the capability to change the molecular interaction Between all the components of the Azeotrope

→ Adding the material separation agents alters the activity of the coefficients of the compounds in the azeotropic mixture
It hence changes the relative volatility of whole Azeotropic mixture

Weight fraction to mole fraction :

→ A liquid mixture 25 wt %, Benzene, 40 wt % Toluene rest of xylene
calculate composition of each in mole fraction

→ Basis = 100g. Benzene - 25 g
Toluene - 40 g
xylene - 35 g

molecular wgt Benzene = 78 g
Toluene = 92 g
xylene = 108 g

No. of moles of $M_B = \frac{31}{78} = 0.32$

$M_T = \frac{40}{92} = 0.43$

$M_X = \frac{35}{108} = 0.32$

mole fraction $x_B = \frac{M_B}{M_B + M_T + M_X} = \frac{0.32}{(0.32 + 0.43 + 0.32)}$

$= 0.299.$

$x_T = \frac{0.43}{1.07} = 0.402$

$x_X = \frac{0.32}{1.07} = 0.299.$

Heat Transfer: Heat Exchanger Basics

Latent Heat :- Amount of heat required to 1 mol of liquid to gaseous phase.

Liquid → gas. → [phase change]

→ Increasing pressure decrease the Latent heat of vaporisation

$Q = \dot{M} C_P \Delta T$

$\dot{m}$ = mass flow $\left(\frac{kg}{hr}\right)$

C_P = specific heat

ΔT = mean Temp difference

$$Q = U A \, LMTD$$

LMTD = Log mean Temp difference

$$LMTD = \frac{[\Delta T_1 - \Delta T_2]}{\left[\frac{\Delta T_1}{\Delta T_2}\right]}$$

ΔT_1 = hot in - cold out

ΔT_2 = hot out - cold in

U = Overall Heat Transfer Coefficient

$$U = \frac{W}{m^2 K}$$

$$Q = U \Delta T$$

$$\frac{kcal}{hr} = \left[\frac{W}{m^2 K}\right] m^2 \times K.$$

Partial condenser	400-200
condenser	$U \left(\frac{W}{m^2 K}\right)$ - 450-500.
coolers	$U \left(\frac{W}{m^2 K}\right)$ - 250-300 $\frac{W}{m^2 K}$.
Reboiler	450-500. $\left[\frac{W}{m^2 K}\right]$
Evaporators	200-500.

Kettle - RB - 800-1000 $\left(\frac{W}{m^2 K}\right)$

Fouling factors:

① Distillate - 0.001 $\frac{ft^2}{Btu}$.

② feed - 0.003 $\frac{ft^2}{Btu}$.

③ condentar - 0.001 $\frac{ft^2}{Btu}$

⑤ steam - 0.0005 $\frac{ft^2}{Btu}$.

⑥. oil/Thermiwl - 0.001. $\frac{ft^2}{(Btu/hr)}$

Condenser → (phase change) - change in latent Heat

(Boiler) → condensation.

Utility → cooling water.

Colling water Requirement

$$(\dot{m}) = \frac{Q \left(\frac{kcal}{hr}\right)}{\left[\frac{CP}{\Delta T}\right]} \quad CP \rightarrow J/kg\text{-}^\circ C, \quad \Delta T \rightarrow {}^\circ C$$

$$= \frac{kcal/hr}{(J/kg\text{-}^\circ C)}$$

$$\dot{m} = \left(\frac{kg}{hr}\right)$$

Utility = $\frac{\text{Heat load}}{\text{Specific heat of water} \times (T_1 - T_2)}$

T_1 = inlet Temp

T_2 = outlet Temp

Heat exchanger area = no. of tube × π × (Length)

Length = Tube length

$$\text{Area} = \frac{\pi}{4} \times (D)^2 \times L.$$

($\pi = 3.14$)

Utility steam :- $\dot{m} = \frac{\text{Heat load}}{\text{Latent heat}} \left(\frac{kg}{hr}\right)$

$Q = \dot{m}\lambda$ (kg/hr)

$\dot{m}$ = mass flow

λ = latent heat (J/kg)

Vapour fraction for heat exchanger

	inlet	outlet	
Condenser :-	1	0	→ full condensation at atmospheric condition
Reboiler	1	-	
Cooler	0	0	no phase change no latent heat distilled will cool.